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An evaluation of the costs and benefits associated with purchasing an anesthesia automated record keeper at Wilford Hall Medical Center

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14. ABSTRACT

In October, 2000, under the guidance of Colonel Jay Ellis, Chief Consultant for Anesthesiology to the Air Force Surgeon General, the researcher began to evaluate the costs and benefits associated with purchasing anesthesia automated record keepers (AARKs) for Wilford Hall Medical Center in San Antonio, Texas. Wilford Halls anesthesia department was devoid of any meaningful information management system, making theft and waste possible, and making research and drug management nearly impossible. Preliminary investigation showed that the Department of Defense (DoD) had evaluated potential AARKs and had chosen to endorse the Anesthesia Information Management System (AIMS) by LifeCare Technologies, thus the focus of the study was a cost-benefit analysis of AIMS, to determine whether or not the benefits would justify the exorbitant costs of its purchase and continued utilization. The literature indicated that savings could be realized in the form of reduced costs of anesthetics, practice improvements through outcomes research, and fewer medicolegal losses. Obstacles include staff resistance and systems support and compatibility, the latter of which caused AIMS to fail at the original DoD test site, Brooke Army Medical Center. Since the DoD pays military medicolegal losses, this benefit would be realized only from the perspective of the DoD; WHMCs budget would not change. This led to evaluation from both of these perspectives. Each cost and each benefit required its own form of investigation, most notably the benefit of increased third party collections. Several of these were found to hold uncertain values, thus scenario and sensitivity analyses were performed on the five most critical elements. The results of best estimates were as follows: From the WHMC perspective, the 10-year net present value (NPV)= -$82,633, with a payback period of 8.210 years; from the DoD perspective, the 10-year NPV= $1,389,354, with a payback period of 2.687 years.

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I offer my sincere thanks to the many others who encouraged and assisted me, not all of whom are included on this page. Commander Daniel Dominguez proved unwavering in his faith in God and in his students. When this project was at its most difficult point, his words, “I knew Jason would come through for us,” served as inspiration. Major Richard Thorp was very informative and flexible in his role as the faculty supervisor of this project. Others I should mention include: Colonel Jay Ellis, Major Joseph Mirrow, Technical Sergeant Ronald Trout, and Mr. Richard Van Hoozer. Each was instrumental and cooperative in helping me to complete this project. Finally, let me thank my preceptor, Colonel Thomas A. Peters, Administrator of Wilford Hall Medical Center, who ensured that I had access to all areas of the largest medical center in the Air Force, as well as ample time to complete this project.

Abstract

In October, 2000, under the guidance of Colonel Jay Ellis, Chief Consultant for Anesthesiology to the Air Force Surgeon General, the researcher began to evaluate the costs and benefits associated with purchasing anesthesia automated record keepers (AARKs) for Wilford Hall Medical Center in San Antonio, Texas. Wilford Hall's anesthesia department was devoid of any meaningful information management system, making theft and waste possible, and making research and drug management nearly impossible. Preliminary investigation showed that the Department of Defense (DoD) had evaluated potential AARKs and had chosen to endorse the Anesthesia Information Management System (AIMS) by LifeCare Technologies, thus the focus of the study was a cost-benefit analysis of AIMS, to determine whether or not the benefits would justify the exorbitant costs of its purchase and continued utilization. The literature indicated that savings could be realized in the form of reduced costs of anesthetics, practice improvements through outcomes research, and fewer medicolegal losses. Obstacles include staff resistance and systems support and compatibility, the latter of which caused AIMS to fail at the original DoD test site, Brooke Army Medical Center. Since the DoD pays military medicolegal losses, this benefit would be realized only from the perspective of the DoD; WHMC's budget would not change. This led to evaluation from both of these perspectives. Each cost and each benefit required its own form of investigation, most notably the benefit of increased third party collections. Several of these were found to hold uncertain values, thus scenario and sensitivity analyses were performed on the five most critical elements. The results of best estimates were as follows: From the WHMC perspective, the 10-year net present value (NPV)= -$82,633, with a payback period of 8.210 years; from the DoD perspective, the 10-year NPV= $1,389,354, with a payback period of 2.687 years. Final recommendations were: 1) do not buy AIMS with O&M

funding at this time, 2) establish a team to address the needs of the anesthesia department, in alignment with other existing needs and realities within WHMC, 3) Seek grant or procurement funding if the team decides to purchase an AARK, 4) If an AARK is purchased on a limited basis, begin implementation in same day surgery for maximum third party reimbursements, and 5) CareSuite by PiCis addresses more of WHMC's needs—if alternative funding is available, buy it.

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Introduction

Conditions which prompted the study

Colonel Jay Ellis, Chief Military Consultant for Anesthesiology to the U.S. Air Force Surgeon General, noted several problems with the current process of anesthesia record keeping at his facility, Wilford Hall Medical Center (WHMC) in San Antonio, Texas. The Air Force's largest medical facility is incapable of assigning anesthesia drug costs to individual patients, and keeps no database of anesthesia practices by which the anesthesiologists could evaluate themselves on performance and practices. Further, current processes are not conducive to efficiency in supply management, and could easily allow pilfering to occur. Colonel Ellis believed that an automated anesthesia record keeper (AARK) might pay for itself through increased collections of third party insurance reimbursements and through improved managerial efficiencies. Practice and management improvements could then be shared with other surgery units throughout the Department of Defense (DoD) (Ellis interview, Oct 7, 2000.)

Current processes: information unmanageable

Anesthesia record keeping

The process of anesthesia record keeping made any efforts at information management terribly burdensome. The anesthetist annotated all pertinent data by hand. These include minute by minute vital signs, drug flow rates, and provider notes. These annotations did not appear to be particularly time consuming, but data were not captured and entered into a database for assessment. Evaluations had to come from investigation of individual anesthesia records. Trying to find trends by entering data manually into a spreadsheet or database would be extremely time consuming, and not at all cost-efficient. Little hope existed for identifying best practices or for

evaluating the anesthesia staff on performance or efficiency (personal observation, 11-28 Oct 2000.)

Anesthetic supplies

An explanation of the anesthesia supply system itself should make its deficiencies apparent. Each weekday, the operating room (OR) pharmacy staff, utilizing individual experience and estimation, would order drugs to be stocked the following weekday. They would place the order using bar code technology (they scan each drug in and punch in how many units they want to order.) They would order extra for weekends, since the OR pharmacy was only manned on weekdays. Additionally, two Pyxis (automated drug dispensing) machines were available to the OR staff to receive certain drugs more quickly when needed. One of these machines was located in the "center core" of the surgical suite (the configuration includes a nurses' station, with supplies and equipment, surrounded by fifteen operating rooms.) The other was located in the "free-for-all" drug room—a forward room attached to the OR pharmacy, accessible at all times to any OR staff who have the cyberlock combination. There are no controlled substances maintained in this "free-for-all" room, nor is there any mechanism for tracking who takes these drugs and on whom they are used (Kettler, Mendoza, Mercado interview, 10 Oct, 2000.)

Under this system, technicians calculate pharmaceutical costs from the data entered into the Medical Expense and Personnel Reporting System (MEPRS, a cost accounting system.) Orders placed with the bar coder, as well as orders for the Pyxis machines and for the controlled drugs in the OR pharmacy are entered into MEPRS—manually for the controlled drugs and electronically for the others (Kettler, Mendoza, Mercado interview, 10 Oct 2000.)

Utilization and costs were calculated quite primitively, by using simple math and answering the following questions: 1) What was the drug's stock level on the last day of the previous month? 2) How many units were ordered during the current month? 3) What is the drug's stock level now, on the last day of the current month? 4) How many patients required any of that drug? The formula to calculate utilization was then the answers to questions (1+2-3)/4. For example, Drug A's stock level at the end of last month was 12 units, 4 units were ordered during the month, there are 10 units in stock at the end of the current month, and 3 patients required the use or preparation of Drug A during the month. The answer to question 1) is 12 units; question 2), 4 units; question 3), 10 units; and question 4), 3 patients. Thus the equation becomes (12+4-10) units/3 patients=6 units used divided by 3 patients, or 2 units per patient others (Kettler, Mendoza, Mercado interview, 10 Oct 2000.)

The anesthesia supply system was devoid of any meaningful information management, and other deficiencies existed. Any unscrupulous individual involved in the process could, with the slightest imagination, formulate a scheme to pilfer without suspicion. If individual units were stolen, they only appeared as increases in utilization and cost per patient, and only then if the thefts were irregular. A clever thief would steal a constant amount on a constant basis. It is very unlikely they would be reported or even noticed, since there was no accountability of individual units. In one instance, Colonel Ellis recalled, an individual was caught in the act, but the opportunity remained. Even controlled drugs could be stolen since the units checked out of the OR pharmacy were not matched with drugs actually administered to each patient. Further, should the DoD approve itemized billing as expected at the onset of this research, this methodology would not serve as adequate justification to third party payers.

Itemized billing on the horizon

Currently, the DoD does not allow its healthcare facilities to itemize their bills, which could substantially improve third party collection (TPC) efforts. As the research began, however, all expectations were that within the next two or three years, itemized billing would be allowed, and, in fact, expected. Colonel Thomas A. Peters, the Administrator of WHMC, felt confident that the DoD would approve a well-justified, skillfully designed process allowing itemized billing, and would like to see this happen at WHMC (Peters interview, Oct 5, 2000.) Most AARKs are able to directly communicate with the billing department and create itemized bills for anesthesia, thus providing a valuable component to such a process.

Itemized billing is a far better business practice than the military's mandated practice of bundling charges. Insurance companies are accustomed to seeing itemized bills, and they are skilled at protesting and delaying payment at every opportunity to keep the money in their coffers as long as possible. The military has a poor record for collecting even these bundled charges. Weak substantiation along with the military's unusual bundling practices make military third party bills easy targets for insurance companies, and act as a significant hurdle to TPC efforts.

Bundling usually ends up selling the government short, even before the payers start their games. Case in point, WHMC must bundle its emergency department charges, setting them at a standard $247 per case—no more, no less. The cranial fracture, with all of its exams and expertise required, is reimbursed at $247, the same rate as the false alarm ear infection that any physician extender could handle. Granted, the latter results in a benefit to the government, but overall this is a very bad business practice for WHMC. According to Major Richard Parks, WHMC's Director of Business Services, in total for fiscal year 2000, WHMC received only

about one third of the charges billed to third party payers (Parks interview, Oct 16, 2000.) This is about average for the DoD.

Statement of the question

The problem of the study can be stated as: Should WHMC acquire an automated anesthesia record keeper; specifically, would the benefits gained by purchasing the DoD-endorsed AARK justify the costs involved in purchasing and operating it?

Literature review and research findings

Important discovery #1

Perhaps the most relevant discovery of this study occurred in its closing stages. In searching for accurate values of historical supply costs, the researcher was directed to Technical Sergeant (TSgt) Ronald Trout, a former anesthesia supply custodian, now working as the non-commissioned officer-in-charge (NCOIC) of the surgery department. When queried, he responded with, “Are you aware of the research Lieutenant Colonel (Lt Col) Masterson and I have been working on.” They had been evaluating the possibility of purchasing CareSuite by PiCis, which performs surgical case tracking, as well as patient information record keeping. The system they hoped for would be able to record and report on patient information from pre-admission, through surgical procedures, to stays in the intensive care unit (ICU), and to discharge. It would also help solve another issue that has concerned WHMC this year—that of scheduling patients into surgery. In essence, the author’s research focused solely on anesthesia record keeping, whereas TSgt Trout and Lt Col Masterson were looking to solve multiple issues, including the anesthesia piece. In fact, they had gone so far as to draft an equipment action request (Air Force Form 601), and had their $2.44 million project on a list of unfunded requirements being considered for purchase. (Trout interview, Mar 8, 2000).

Unfortunately, the author discovered this after both projects were nearly complete. Combined efforts may have proven valuable. The anesthesia component was only one of several of the alternate project's capabilities, and Colonel Ellis did not believe it included intraoperative anesthesia record keeping capacity. Nonetheless, Sergeant Trout provided some key information for this project, which will be discussed later.

Important finding #2: DoD AARK preference

Colonel Ellis pointed out in an interview that the DoD had reviewed a number of AARKs and had chosen to endorse the Anesthesia Information Management System (AIMS), produced by LifeCare Technologies (Ellis interview, October 7, 2000.) Van Hoozer provided a copy of a statement of work from the DoD that verified the DoD endorsement (Van Hoozer facsimile, February 12, 2001.) The focus of the research thus turned toward AIMS.

This AARK had been installed at Brooke Army Medical Center in San Antonio, Texas, but failed due to poor systems compatibility and network support. A panel of the anesthesia staff voted by a majority of about 60 percent to abandon the project. Complaints included that the system would crash at least once each week, and data retrieval after crashes was time consuming and occasionally unsuccessful. Those who voted to keep AIMS appeared to mostly be anesthesiologists who had become very familiar with how it worked and what the capabilities were.

There are a few key lessons to take away from the failure of AIMS at BAMC. First and foremost, systems compatibility and network capacity to support AIMS are crucial to successful implementation. Second, AIMS is not a simple, user-friendly package. For the most part, those who took the time to learn the system voted to continue using it, but most did not take that time and most voted to kill it. Third, integrating a new system into the anesthesia culture can be

difficult. There were those who resisted AIMS from the start, including anesthesia staff members computer systems personnel. Efforts should be made to capture the support of key stakeholders when implementing a new system.

A bit of history

Harvey Cushing and E.A. Codman were the pioneers of the anesthetic record. Debate lingers over which should be credited as the inventor, but at least the literature agrees that in 1894 at Massachusetts General Hospital the first anesthetic record was created, reportedly to settle a wager between the two as to who was the better "etherizer" (Dear, Panten, & Lubarsky, Panten, & Lubarsky, 1999; Kirby & Gravenstein, 1994.) It was Cushing, in 1902, who developed the basic framework for today's record when he created a new chart with space to record blood pressure, respirations, and pulse at continuous regular intervals (Collins, 1993.) Codman later developed outcome analysis; he would identify patterns of poor outcome, and then adjust his surgical practice to improve results. As early as 1914, Codman charged that hospitals must (Kirby & Gravenstein, 1994):

- Identify results
- Analyze results to know strong and weak points
- Compare results with other hospitals
- Care for cases they can do well, and avoid those which they are poorly qualified for
- Welcome publicity for successes AND for errors, so the public will assist them when necessary
- Promote staff members on "what they can accomplish for their patients"

Today, anesthesia records are used for much more than Cushing or even Codman envisioned, including efforts to maximize hospital net revenues. Many factors have led to an

increase in national healthcare spending from 5.3 percent of America's gross domestic product in 1960 to more than 14 percent at times during the 1990's. Cost containment has become a major concern. Factors of note include the introduction of Medicare and Medicaid in 1965, the aging of the population, the expense of rapidly advancing technology, and third party insurance leading to increased utilization, i.e., moral hazard (Sultz & Young, 1999.)

According to Barash, et al, the anesthesiologist has a distinct role in conserving healthcare dollars. This role includes identifying candidates for outpatient surgery, evaluating anesthesia technology, evaluating the cost-effectiveness of anticipated care, and managing patient expectations. Further, an estimated three to five percent of the nation's healthcare costs are influenced by anesthesiologists (Barash, Cullen, & Stoelting, 1997.)

Rising costs in healthcare served as an impetus for many improvements in the industry, including the AARK, but the primary motivation was quality of care. An AARK records and collects data, stores them in a database and facilitates the use of data for patient care and for managerial improvements (Dear, Panten, & Lubarsky, Panten, & Lubarsky, 1999.)

Uses of the anesthetic record

An anesthetic record is used as far more than simply a log book of anesthesia events. Kirby and Gravenstein listed 35 distinct uses of the anesthetic record, including eight under the heading "Billing and Reimbursement." (Kirby & Gravenstein, 1994.) Although this may be the most comprehensive list, of three texts listing uses of the anesthetic record the researcher prefers that included in the text by Jerry and Susan Dorsch. This list includes: log of events, performance assessment, research, education, billing, administrative functions (such as evaluating utilization of facilities, personnel, etc.), and quality assurance (Dorsch & Dorsch, 1999.) Also of note, the record is commonly used as a medicolegal document, may be evaluated during accreditation, and

is viewed as an aid in vigilance for the anesthesia staff (Ehrenwerth & Eisenkraft, 1993; Kirby & Gravenstein, 1994.)

Users of the anesthetic record

As there are many uses of the anesthetic record, certainly there are many users as well. Numerous medical and nonmedical personnel utilize this document. Physicians and nurses caring for patients in the postanesthesia care unit (PACU), in postoperative surgical wards, and in the ICU require legible, accurate anesthetic records, and are among the most important users since they use the information to further care for the patients. By comparing lists of users from two textbooks, the researcher fashioned the following list of primary users of the anesthetic record (Table 1) (Ehrenworth & Eisenkraft, 1993; Kirby & Gravenstein, 1994.)

Table 1

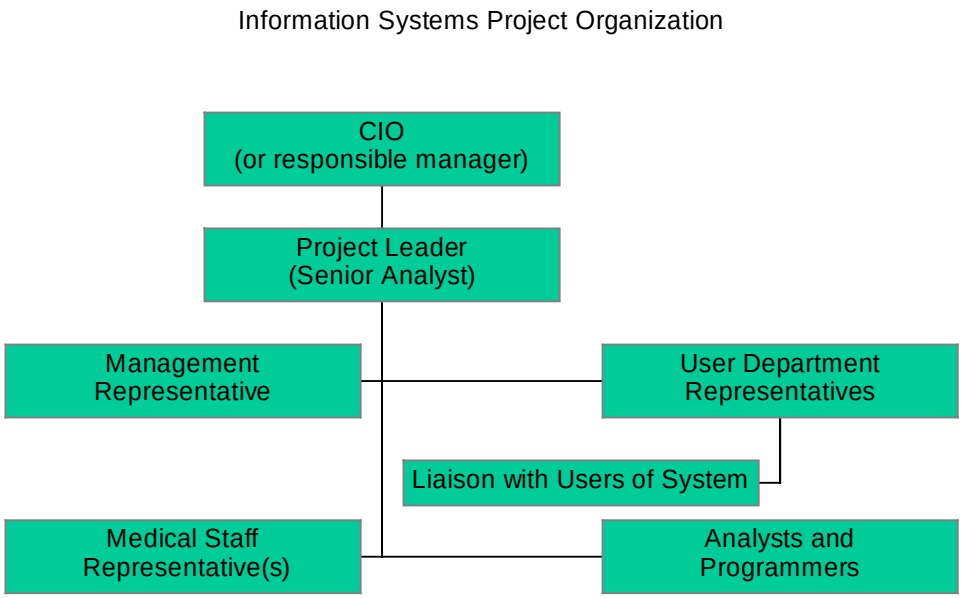
Primary Users of the Anesthetic Record
Initial anesthesiologists and anesthetists
Subsequent anesthesiologists and anesthetists
Postoperative physicians and nurses and other providers
Administrators
Financial managers and accountants
Quality assurance and peer review personnel
Lawyers
Accreditors
Healthcare researchers and clinical investigators
Insurers
Risk managers
Patients and families

Appropriate decision team

Austin and Boxerman, in their text, *Information Systems for Health Services Administration*, assert that large-scale information system (IS) projects should involve the efforts of a project team. Later in this literature review, evidence corroborates the need for user buy-in for successful implementation of an AARK. As opposed to a single researcher, a project team appropriate to fully evaluate anesthesia information needs should include anesthesia staff members, surgery department managers, and information analysts at a minimum. Austin and Boxerman would suggest a senior analyst as the project leader. Their suggested IS project

hierarchy is illustrated below (Figure 1) (Austin & Boxerman, 1998.) Wilford Hall should consider who should be included from the list of users in Table 1 above.

Figure 1



Evaluation criteria

Generally, health management information systems should achieve some, if not all, of the following: increase productivity, free up providers' time for patient care, assist and improve decision making, improve communication and coordination between sections, increase the rate and quality of information flow, and improve the organization's ability to adapt quickly. Information collected should be accurate, verifiable, unbiased, easy to interpret, relevant for decision making, and economically viable to collect and analyze (Austin & Boxerman, 1998.)

Ehrenwirth and Eisenkraft quoted Gravenstein and Feldman, agreeing that an acceptable AARK must accomplish one or more of the following (Gravenstein & Feldman, 1989; Ehrenwirth & Eisenkraft, 1993):

- Improve patient care
- Decrease cost
- Reduce clinician workload
- Be medicolegally compelling
- Perform important task(s) that would otherwise not be done

Austin and Boxerman deemed the following as criteria for evaluating potential software purchases (Table 2) (Austin & Boxerman, 1998):

TABLE 2

Software Evaluation Criteria
Congruence with organizational requirements
Level of satisfaction of other users
Compatibility with existing hardware and software
Ability to interface/integrate with other applications
Support available for training, documentation, and maintenance
Costs of software, hardware, implementation, maintenance, and upgrades
Financial stability of vendor

In alignment with the first criterion, congruence with organizational requirements, systems purchase decisions should be linked to the organization's strategic plan (Snyder-Halpern & Wagner, 2000.) To this end, WHMC's stated mission, vision, and primary goals are included as Attachment A. Notably, it's mission statement ends with "…supported by education, training, and research." Apparently, the executive staff believes these three are key building blocks

towards preparing its medics to support the nation's war fighters and to build healthy communities.

Relating to the criteria of compatibility and integration, WHMC created and now utilizes the Integrated Clinical Database (ICDB) throughout the medical center. Both the clinical staff and management appear to be very pleased with this system, which allows retrieval of patient information from nearly any terminal in the facility. Any AARK successfully implemented at WHMC should be able to communicate with ICDB, as well as with its base, the Composite Health Care System (CHCS.)

Getzen summarizes the primary benefits to be considered for any health project as health, productivity, and reductions in future medical costs, with costs summarized as medical care and administration, follow-up and treatment damages, provider time and effort, and time and pain endured by the patient and family (Getzen, 1997.) Barash, et al, suggest that all costs and benefits should be considered, as well as risks. They continue to describe several methods of economic analysis, including cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA) (Barash, Cullen, & Stoelting, 1997.)

Cost-benefit analysis v. Cost-effectiveness analysis

"It is best to think of the cost-benefit approach as a way of organizing thought rather than as a substitute for it (Drummond, 1981.)"

Getzen explained that CBA is not a tool that makes decisions, but is a framework to help make decision making rational, consistent, and easily communicated. It can be a comparison of formal assignments of dollar values to all costs and benefits related to multiple alternatives, or it can simply be a balancing of the advantages and disadvantages of one or more options. Costs and

benefits should, however, be evaluated in relative terms, such as marginal costs and benefits, and opportunity cost. If the change in benefits outweighs the change in costs, an option is positive. This is what marginal means, "a change in," though it can also be defined as "the effect of one more." Decisions should be made only on factors that change, i.e., the net costs and benefits. Opportunity cost, defined as the most valuable forgone alternative (Getzen, 1997,) for this evaluation appears to be the value of the government holding onto the dollars, though within the facility the competition appears to be from a competing radiology initiative. For this analysis, the ten-year government bond rate will suffice as representative of the opportunity cost, as indicated in calculations of the net present value under various scenarios.

Barash (1997) and Getzen (1997) agree that CBA has limitations. In some cases a value may be assigned to changes in health status, as in quality adjusted life years estimations, but it can be difficult to assign values to these and other variables. Unless medical facts are well known, economic analysis under a formal CBA may be impossible.)

Cost-effectiveness analysis is a form of CBA that compares alternatives by fully assigning costs, but without assigning dollar values to the benefits. Under CEA, a decision maker or decision team can make decisions with a subjective evaluation of benefits (Getzen, 1997.) Barash (1997) stipulates that future cash flows should be discounted to reflect their present values, and that sensitivity analyses should be performed on variables. Net present value and sensitivity analyses are common capital budget project analysis tools, and are utilized in this project.

Decisions under uncertainty

If probabilities of the various scenarios, i.e., states of nature, are known or can be estimated, then decisions can be made based on expected values. This is known as decision

making under risk. When such probabilities are unknown and the decision maker is unwilling to make estimates, then expected values cannot be calculated, and the situation is known as decision making under uncertainty. In such instances the decision-maker has tools by which to evaluate alternatives. The maximax criterion would choose the option with the greatest potential profit gain. Minimin would choose the lowest possible total cost. Maximin would select the alternative with the greatest minimum profit, and would select the option with the least maximum cost. The minimax regret criterion looks at profits under various scenarios, and would choose the option that minimizes the potential "regret," which is calculated as difference between each alternative's maximum potential profit and its profits under the least desirable scenario (Austin & Boxerman 2, 1995.)

Components of an AIS

The general configuration of an anesthesia information system with AARKs is shown below in Figure 1. Included are modules for data input and retrieval in the preoperative area and in the PACU, however these components may not be available in all packages and can add to the total cost significantly. At a minimum, AARKs would be connected to a fileserver, which would connect to anesthesia provider workstations and a printer. Ideally, all hospital network systems could communicate with each other, and information from the preoperative area, the ORs, the PACU, the laboratory, radiology, provider offices, and even the ICU and other wards could all be accessed from any terminal in the facility (Dorsch & Dorsch, 1999.) A connection to the billing office is also generally included, but was not included in the figure. The package evaluated by Masterson and Trout would appear to accomplish all of this, including bi-directional communication with ICDB and CHCS (Masterson & Trout interview, March 21, 2001.) This project focuses on AIMS, which does not offer modules for the pre- or postoperative

areas, and currently does not communicate well with CHCS. It is expected to be able to communicate with CHCS II when it is installed (Van Hoozer e-mail, March 11, 2001,) though this has yet to be proven and could take two or three years to show.

Figure 2

Common AIS Configuration

Costs of an AARK

Jones (2000) organized the "true cost" of running a system into ten categories in addition to the purchase price. They are: (1) technical support and maintenance, (2) personnel costs, including training, (3) applications development, (4) upgrades, (5) consumables, (6) insurance, (7) downtime, (8) security, (9) equipment accommodation, such as cabling, and (10) depreciation. Future expansion is often not planned for, and is usually expensive. When it is necessary to estimate certain costs, it is prudent to do so conservatively, since hidden costs may crop up and the final cost of various items is often underestimated. Purchase price, on average, comprises only 10-35% of total lifetime costs of computer systems (Jones, 2000.)

Some of the categories above are not included in the analysis, because the AARK purchase would create no calculable difference in cash flow, or because they were combined in the prices estimated by the AIMS representative. Notably, training was included in the software purchase price of $32,000 per operating location, and upgrades were combined with technical support and maintenance at a price of 15 percent of the software purchase price. Cabling is included in the breakout of hardware costs, which Jones did not include as a category (Van Hoozer e-mail, January 29, 2001.) As a government hospital, there is little reason to account for depreciation, so that item is excluded.

At the researcher's request, Van Hoozer provided a list of the costs BAMC incurred in installing AIMS. The researcher could not properly evaluate what differences there might be in hardware requirements, except that WHMC is unlikely to need the workstation upgrades, as it is installing Dell 800's throughout the facility and has ample network capacity for the AARKs. The BAMC costs were, therefore, used as best estimates for hardware costs. Literature from 1999 suggests that AARKs cost between $12,000 and $35,000 per operating location, and that

software maintenance and upgrades are often combined, running between 5 to 20 percent of the purchase price (Dorsch & Dorsch, 1999.) At $32,000 and 15 percent, this would put AIMS on the high end of these cost ranges.

Those who speak against AARKs complain that they record artifacts, which are electronic misreadings. They fear this could result in increased liability if poor outcomes were to occur (Gravenstein & Kirby, 1996.) Others argue that vigilance, or mental absorption of information decreases when data are not manually recorded (Heinrichs, Monk, & Eberle, 1997.) Some mention that space in the OR can be tight, and the environment potentially hazardous to expensive computer systems (Dear, Panten, & Lubarsky, 1999,) but even the sources that mention these concerns generally support AARKs. Of course, the primary concern noted everywhere in the literature is the purchase price.

Benefits of an AARK

An AARK provides numerous benefits, but many are difficult to quantify. The automated record is inarguably more easily discernable, offering continuous high quality documentation (Heinrichs, Monk, & Eberle, 1997.) Many of the potentially quantifiable benefits of an AARK stem from this fact, and that the data are collected and stored for review and analysis.

The preponderance of the literature argues that an AARK can save time for the anesthesiologists, but some studies show no statistically significant change in charting time (Dorsch & Dorsch, 1999.) A study by Meijler (1987) found that logging data took 6 percent of anesthesiologists' time during general surgery, and 12 percent during coronary surgery (Kirby & Gravenstein, 1994.) This data could be combined with salary data to come to an estimation of the value of this benefit.

Certainly, there could be an improvement in billing, as verified throughout the literature. Most AARKs, including AIMS, carry a billing module that creates itemized bills. Information required for billing includes the name of the insurer, patient demographics, specifics about the case, i.e., time of surgery, diagnosis, intraoperative data on anesthesia and vital signs, etc., and concurrency, which is the number of anesthesia drugs monitored concurrently (Dorsch & Dorsch, 1999.) Only the difference in reimbursement should be considered in this analysis--that is, the difference between what would be collected under the expected itemized billing with and without an AARK.

The medicolegal benefits provided by AARKs are almost universally recognized in the literature. Those who voice concerns appear to be providers who fear that the increased accuracy poses a threat of increased litigation. All experts writing on the subject agreed, however that the medicolegal benefit was real. According to Holly Mackey, Chief of Medical Claims at Lackland AFB, Texas, there were three potentially high dollar claims at WHMC between 1998-2000, in which the clarity of the anesthetic record was of particular concern (Mackey interview, March 2, 2001.) Sergeant Trout was familiar with all three cases and declared that there is “no doubt in (his) mind that an AARK would have prevented those claims (Trout interview, March 6, 2001.) Handwritten records, which is the modus operandi at WHMC, can be incomplete or illegible often at the time of critical events when it is most important to have an accurate record. The anesthesia record is the cornerstone of anesthesia litigation, and, if clear and complete, almost always defends a well managed case (Dorsch & Dorsch, 1999.) Multiple sources recanted the statement, “if it isn’t charted, it didn’t happen (Kirby & Gravenstein, 1994.)”

“Risk managers applaud, and malpractice companies give rebates” to departments using AARKs

(Dear, Panten, & Lubarsky, 1999.)" According to Heinrichs, Monk, and Eberle (1997) the advantages outweigh costs "by far."

Duke University Medical Center's Department of Anesthesiology has realized annual savings of $900,000 in anesthetics alone, without diminishing the quality of care. Using an AIS, they targeted high cost areas of practice and began educated anesthetists on developed practice guidelines (Coleman, Sanderson, & Lubarsky, 1997.) Anesthetics account for 8 to 12 percent of a hospital's total drug expenses (Thomas & Martin, 2000,) so there is certainly potential for savings. Reduction in waste and improvement in drug utilization practices helped Deaconess Hospital of Evansville, Indiana, cut drug expenses by $200,000 per year (Thomas & Martin, 2000.) Van Hoozer and Colonel Ellis agree that WHMC could conservatively expect a 20 percent reduction in anesthesia drug costs—"at least" (Van Hoozer e-mail, March 3, 2001; Ellis interview, March 2, 2001.)

Outcomes research is next to impossible right now at WHMC, because data are not captured to research. The literature does not include recommendations on how to quantify this benefit, but universally exclaims its virtue. By comparing results of alternative treatment modalities, best practices, or at least more cost-effective treatment protocols, can be identified and taught. Further, individual providers could be evaluated based on performance, with less effective practitioners identified for education on more cost-effective protocols (Austin & Boxerman, 1998.) The benefit would be much greater from the perspective of DoD than that of WHMC alone, if WHMC was to share study results. If multiple facilities are able to pool data in the future, the benefits could be realized throughout the DoD. Of concern to the researcher, however, is that of the facilities who purchase these expensive systems with research capabilities, the majority fail to utilize this capability (Dear, Panten, & Lubarsky, 1999.)

Perceptions, attitudes, and poor ease of system use contribute to this reality (Rowe, Galletly, & Henderson, 1992.) Colonel Ellis envisions a database collecting data from every OR in the DoD. Once the quantity of data grew, the potential research benefits would be endless (Masterson, Ellis, & Trout interview, March 21, 2001.)

Other benefits include performance assessment capability, possible reduction in paper use, accessibility of information (Dorsch & Dorsch, 1999,) and meeting compliance and regulatory requirements (Dear, Panten, & Lubarsky, 1999.) If armed with a scheduling module, AISs can manage staff and case scheduling, thus maximizing the facility's capacity to treat patients. This has been a particular concern of the surgery department at WHMC, and is addressed with the CareSuite package proposed by Masterson and Trout (Masterson, Ellis, & Trout interview, March 21, 2001.)

Several authors relate the benefits of AARKs to patient safety. Cooper (2000-2001) identified two "good safety arguments" for them. First, doctors need to know what happened and why after adverse incidents and near misses. E.A. Codman would surely agree. Second, it would provide a database for researching global safety issues and for comparing healthcare organizations. He further relates hospitals to modern factories. To run a factory, one must track the product and its parts; to run a hospital one must keep track of "where patients are, and what's happening to them throughout" their stay in the hospital.

Phillips (2000-2001) alluded to a 1988 study by Caplan in which 14 healthy young patients unexpectedly arrested under spinal anesthesia. Hand records were deemed "not very worthwhile", with several anesthetists admitting that they were not paying close attention at the time of the adverse incidents. They were unable to answer questions about what happened in what order, such as whether bradycardia or cyanosis occurred before or after the arrest.

Consequently, patterns could not be established, and practices could not be adjusted for improvement.

Relevant financial considerations

Important finding #3: DoD itemized billing

One of the author's fellow graduate students, Lieutenant Commander Ann Forrest, provided a hard copy of a presentation given by Major Rose Layman, Uniform Business Office Manager for the DoD. Included was a slide indicating that the DoD expects itemized billing for outpatient services to begin in fiscal year (FY) 2002, and another that showed inpatient services starting in FY 2003. The latter slide (Appendix B) drew the researcher's interest, because it seemed to indicate that charges would continue to be billed under diagnosis-related group (DRG) methodology, with only professional fees broken out. E-mail correspondence with Layman confirmed that inpatient services would continue to be billed by DRG for the foreseeable future, except for the professional fees which should be broken out starting in FY 2003 (Layman e-mail, March 15, 2001.) Anesthetics required during ambulatory procedure visits, however, could be itemized beginning in FY 2002 (Layman e-mail, March 22, 2001.)

Recent legislation expanding DoD healthcare benefits and an already downward trend in TPC should work against the increase in TPC expected to result from itemized billing. As benefits expand, fewer beneficiaries are expected to choose or maintain other health insurance, thus there will be fewer cases from which to charge third party payers. Fully itemized billing likely would more than compensate for the forces leading to a decline in TPC, but for the purposes of this study, the itemized billing benefit is zero. This is discussed more in *Results*.

Possible funding mechanisms

You lust, and have not: you kill, and desire to have, and cannot obtain: you fight and war, yet you have not, because you ask not.

–James 4:2, King James Bible

A 1990 survey by the American Society of Anesthesiologists showed that AARKs were the technology most desired in the field by anesthesiologists (Anesthesiology News, 1991,) yet two decades after AARK technology was first introduced it has yet to win a stronghold in the marketplace. They are expensive, and as predicted by Ehrenwirth and Eisenkraft, their complexity has kept prices from dropping, as many systems packages will do over time (Ehrenwirth & Eisenkraft, 1993; Masterson, Ellis, & Trout interview, March 21, 2001.) Operations and maintenance (O&M) funding may require the least effort of available funding options for a major purchase like an AARK, but it is also the most painful for the organization.

Procurement funds can be requested and petitioned for. Funding for high dollar facility and systems initiatives may be requested by WHMC through its major command, Air Education and Training Command, which would then prioritize its list of procurement funding requests, and ask Headquarters US Air Force for the money (Westbrook interview, Mar 19, 2001.) There is stiff competition for these dollars, but the best justifications often get funded, and WHMC would be able to use their O&M dollars on other priorities.

Grant money is another possible source of funding. In fact, DoD fully funded BAMC's purchase and implementation of AIMS (Trout interview, March 6, 2001.) This discovery led the researcher to perform his analysis from the perspectives of both WHMC and the DoD.

Purpose statement

The purpose of this study was to identify cost and benefit data, and translate them into information the executive and anesthesia leaders of WHMC could use to determine whether or not installing the DoD-endorsed AARK, AIMS, would be an appropriate course of action to address their nearly complete lack of information management capability in anesthesia.

Method and procedures

Since the solicitation of grant money from the DoD was identified as a genuine funding possibility, the analysis looked at the costs and benefits from the perspectives of both WHMC and the DoD. For the purposes of soliciting procurement funding, which ultimately would be funded at the Headquarters U.S. Air Force level, the results of the WHMC perspective can be used, since the presently quantifiable costs and benefits would be identical.

Despite the uncertainty of some of the variables, the researcher chose CBA over CEA, electing to assign dollar values to all benefits that he reasonably could. The discussion section included elements of CEA, as some relevant benefits were not quantifiable and could not assuredly be projected as future cash flows or savings to WHMC or the DoD.

Known values or best estimates were inserted into cash flow timelines. Using cash flows alone, the payback period was calculated from both perspectives. Future cash flows were also discounted to estimate their present values, and then tabulated to determine the net present values (NPVs.) Discount factors are determined by the opportunity cost of the project, i.e., the value of the best alternative use of the funds. For a government capital budgeting project such as this, a reasonable discount factor would be the 10-year government bond rate, which has averaged about a six percent yield (Thorp interview, Feb 27, 2001.) Thus to calculate NPV, a discount factor of six percent was used.

Each cost and each benefit required its own research methodology, which is discussed with its findings in the Results sections. Generally, the researcher played the role of investigator, relying primarily on interviews, personal observations, and literature findings. In some instances, such as for the third party collections benefit, the investigator searched diligently for clues, and then pieced them together. To address the uncertainty of multiple costs and benefits, sensitivity analyses were performed, with the researcher identifying best case, worst case, and best estimate scenarios, using the Microsoft Excel scenarios tool. The best guess values matched those included in the cash flow timeline.

Results

Cost-benefit cash flows, including calculations of NPVs and payback, are included as Appendix A for the WHMC perspective and as Appendix B for the DoD perspective. Scenario analyses follow in Appendices C-G, which evaluate possible scenarios including best guess, best case and worst case scenarios. Incremental scenarios are included to provide sensitivity analyses. Each cost and benefit required its own explanation. For the reader's sake, the following paragraphs were organized in accordance with the order of costs and benefits listed on the cost-benefit timelines.

Costs

Software purchase price

The purchase price was quoted by the AIMS representative, Van Hoozer, as $32,000 per operating location. This price was on the high end of the range expected from the literature of $12,000 to $35,000 each. Full installation at WHMC would include 18 operatories and 2 labor and delivery suites, for a total of 20 operating locations. Thus, the total software purchase price

would be $640,000. Initial training was included in this price. Scenario analysis was unnecessary because the datum is a quoted price.

Software maintenance and upgrades

Again, Van Hoozer's price served as the datum source for this cost. As the literature predicted might be the case, maintenance and upgrades were included together in one price, within the range of 5 to 20 percent of the software purchase price. For this purchase, the cost would be 15 percent, or $48,000 annually, including upgrade training.

Hardware purchase and maintenance

Hardware requirements, as the literature indicated, depend on the compatibility of current systems in place at WHMC. To precisely determine the hardware costs WHMC would incur to support AIMS would require compatibility testing, which the researcher was unable to coordinate for this evaluation. Van Hoozer provided the hardware requirements for BAMC, which he suggested were grossly overpriced by the hardware contractor. He further suggested that through governmental contracts, WHMC should easily see a 30% reduction from the costs BAMC incurred. Conservatively, the researcher chose the full cost from BAMC as the best guess scenario, though other scenarios were evaluated.

One exception was the cost of workstations, i.e., computers, monitors, etc., for each anesthesiologist's office, which cost BAMC $4,790 per office for sufficient computer equipment. The researcher replaced this value with zero, because at the time of this writing, WHMC was in the process of installing Dell 800 workstations throughout the medical center, and had recently completed installation of a fiber optic backbone for the facility that should make further workstation upgrades unnecessary. Two scenarios were evaluated for this cost: either the existing workstations will be compatible or they will not. Hardware costs were estimated at $158,730,

assuming compatibility. If each of the 22 anesthesiologists at WHMC need the $4,790 workstation, the hardware costs would total $264,110 instead of $158,730. Of particular concern, Van Hoozer wrote that AIMS had yet to be tested for compatibility with such standard desktop applications as Microsoft Office (Van Hoozer e-mail, March 6, 2001.) This should be evaluated before negotiating a price.

The cost of the maintenance contract would depend on negotiations with the specific contractor chosen, and the only information the researcher had to go on was the literature's estimation of between 5 and 20 percent of the purchase price, and the quoted price for the software. Fifteen percent was selected as a reasonable, conservative best guess, which totals $23,810 annually.

Additional staffing

No literature specifically outlined what additional staffing may be required, and it may be assumed that this requirement would be site specific. Colonel Ellis estimated that one half full-time equivalent (FTE) would be required in the billing department, as well as a half FTE for data analysis and another half for system management (Col Ellis e-mail, February 27, 2001.) This estimate was supported by Van Hoozer, except that he believed the two half FTEs for data analysis and system management would likely be combined in one individual (Van Hoozer e-mail, March 6, 2001.) Thus, the expected additional staffing was estimated at one half FTE in billing and one FTE as the system manager and data analyst.

Through the WHMC Master Unit Manning Document, and with the assistance of Ms. Annette Martinez (February 23, 2001) in the Civilian Personnel Liaison Office, the researcher found that civilian billing clerks at WHMC are usually paid at the GS 5 level, at a total cost to the government for one half FTE of $16,920 annually**.** The system manager priced out at $59,472

annually, as a GS 11 employee. These duties, however, would almost certainly be filled with contracts. Masterson and Trout priced their system manager at $32,000 per year, but when the researcher asked Trout if that was realistic, he responded that the price had probably gone up, and that $35,000 to $40,000 might be more realistic. He then qualified that by saying that, in San Antonio, we could get someone for $35,000 (Trout interview, March 6, 2001.) The researcher conservatively chose $40,000 as the expected value for this FTE. A scenario and sensitivity analysis of the system manager's salary was included at Appendix C. Considering the billing workload projected in the TPC calculation below, the researcher no longer expected a need for 0.5 FTE in billing, but approximately 0.2. The price for this would likely be added onto an existing contract, with an increase in cost of approximately $4,600 annually.

Supplies

Supply cost data were estimated from the supply costs seen at BAMC, which is a similar sized military medical center. On average, BAMC used 3 reams of printer paper each week, and required a new laser printer cartridge approximately every six months (Van Hoozer e-mail, February 26, 2001.) The cost to WHMC for 150 reams of paper for one year would be approximately $3,000, and the cost of two high quality laser printer cartridges could be as high as $400 (Office supplies 2000, 1999.) The expected costs total $3,400, which may seem high, but these numbers were derived from the information from the AIMS representative, and assuming costs would be lower seemed unwise.

Benefits

Drug savings

The OR pharmacist, Ms. Patricia Kettler, recorded monthly spending on OR anesthetics until around the end of Spring 2000. Further evidence of the lack of information management,

the data were not being used for any analysis, so Ms. Kettler stopped tracking this information. The data had been kept in a spreadsheet, originally by Trout, who served as the supply custodian before his role as NCOIC of Surgery. This file could not be located. The estimates for the total spending on anesthetics came from the recollection of those who had ordered the supplies and recorded the data. Kettler's estimate was $45,000 to $50,000 monthly (Kettler e-mail, March 5, 2001.) Trout felt Kettler's estimate was a little low, but that her's was a fair estimate. From these interviews, the researcher expected that the average would be slightly more than $50,000 per month, so he chose $50,000 as a conservative best guess. The total spending on anesthetics was therefore estimated at $600,000 per year.

Again, the literature failed to offer specifics on how much a healthcare organization could expect to save in drug management, and the lack of data available at WHMC made this estimation all the more subjective. The literature did include examples of large savings, however. Colonel Ellis, as the Air Force Surgeon General's consultant of choice on matters of anesthesiology, was surely the best person to make an estimate for the potential drug savings in his own facility. Further adding to Ellis' credibility in this matter was that throughout the research, he consistently exhibited interest in getting to the truth of costs and benefits, as opposed to justifying a pet project he would like for his department. The researcher trusted Ellis' sincerity and his expertise. Ellis estimated that WHMC would easily save 20 percent of drug costs with the AARKs, through elimination of waste, deterring or identifying theft, and management of drug utilization. "At least 20 percent," he said (Ellis interview, March 2, 2001.) Van Hoozer felt this was a reasonable estimation as well (Van Hoozer e-mail, March 3, 2001.) The researcher's observations and interviews convinced him that more than 20 percent was likely, but 20 percent was accepted as the researcher's estimate for savings through the

management of anesthetics, totaling $120,000 in annual savings. A scenario and sensitivity analysis of this benefit was included at Appendix D.

Increase in third party collections

Of all costs and benefits considered, this benefit required the most thought and detective work. A copy of a slide presentation given by the DoD Uniform Business Office Manager, Major Rose Layman, led the researcher to contact Layman for clarification. Until that time, the researcher believed fully itemized billing would be possible for WHMC in the near future. The slides indicated that only professional fees would be broken out for inpatient services, which were scheduled to be itemized beginning in FY 2003. Layman confirmed this (Layman e-mail, March 15, 2001.)

Consequently, the benefit calculation would have been quite simple—zero—were the entirety of surgical anesthesia performed on an inpatient basis, but that is not the case. Late one night, near the conclusion of the project the researcher pondered, “What about outpatient surgery?” A follow-up e-mail to Layman confirmed that ambulatory procedure visits (APVs) are indeed billed under the outpatient billing methodology, which was projected to be itemized starting in FY 2002 (Layman e-mail, March 22, 2001.) Further investigation found that the cost of anesthetics used during APVs can be billed separately under itemized billing (Graham, 2000; Ellis e-mail, March 23, 2001.)

The calculation proceeded as follows: With the help of the MEPRS manager, Mildred Modzelesky, the researcher tabulated that 40.24 percent of all anesthesia expenses at WHMC were accounted to APVs in FY 2000. This was conservatively rounded down to 40 percent. Since it was previously estimated that $600,000 in anesthetics were purchased each year, the cost of APV anesthetics could be estimated at 40 percent of $600,000, which equals $240,000. If the

reader recalls, however, the researcher predicted 20 percent savings in drug costs, leaving $192,000 expected in anesthetics that could be included in itemized bills each year. Only 23.96% of military patients in WHMC's region carry other health insurance (Department of Defense, 1999,) narrowing the pot to $46,003. The last element of the calculation was to adjust for the historical reality that only one out of every three dollars billed to third party payers has been collected at WHMC (Parks interview, October 16, 2000.) Thus, the investigator concluded that AARKs could be expected to net $15,334 in additional TPC dollars annually, resulting from itemized billing of APVs. To summarize, the formula for this calculation was as follows:

($600,000/year * 40%) – 20%) * 23.96% * 1/3 = $15,334/year

or

$600,000/year * 0.4 * 0.8 * 0.2396 / 3 = $15,334/year

It may be expected that itemized billing will garner more than the one-third collection rate historically seen, so this is indeed a conservative estimate. A scenario and sensitivity analysis was included at Appendix E, to look at how changes in the percent of billed charges collected would impact the project.

Supplies avoided

Staff Sergeant John Whitaker currently serves as the supply custodian for anesthesiology. His original estimate was that only $60 to $80 per month would be avoided in supplies (Whitaker e-mail, February 28, 2001.) Upon further research, and clarification on what supplies should be included, his final estimate came to between $170 and $200 per month (Whitaker e-mail, March 6, 2001.) The researcher decided, neither conservatively, nor optimistically, to use $185 per month. He felt the supply costs to be incurred were estimated conservatively, so conservatism

was already accounted for in the net cost of supplies. Thus, the expected annual benefit of supplies avoided totaled $2,220, primarily consisting of paper and printer cartridges.

Medicolegal benefits

Ms. Kathy Bulger, in her nine years as the Risk Manager at WHMC, did not recall any cases that hinged specifically on the handwritten anesthetic record. She referred the researcher to Ms. Holly Mackey of the Lackland Air Force Base legal office for verification and further research (Bulger telephone correspondence, February 20, 2001.)

Mackey researched the matter thoroughly. Unfortunately, files are only kept for three years, so the available data were limited. Though the anesthesia record is the first place lawyers go following a catastrophic even, only three cases directly involved problems with the anesthetic record within the years of 1998 through 2000. One cost the government $200,000 in the form of a settlement. The other two, at the time of this writing, were current cases with the potential for high dollar losses (Mackey telephone correspondence, March 2, 2001.) Sergeant Trout clearly recalled each of these cases, and matter-of-factly stated that there was “no doubt in (his) mind that an AARK would have prevented all three” lawsuits (Trout interview, March 6, 2001.) Texas state law sets maximum damages at $1.5 million in cases involving a fatality; if the patient survives the cost can go even higher (Mackey telephone correspondence, March 2, 2001.) Since neither Mackey nor Bulger could recall such a large medicolegal loss, the researcher considered million dollar losses an unpredictable and unlikely scenario, and valued the estimated annual cost avoidance at $200,000. Year-to-year variances for this benefit could be very large, but with such limited data, this was the most reasonable estimate.

It is important to note that medicolegal losses are not paid from the facility’s budget. The DoD pays the bill for these (Bulger e-mail correspondence, February 22, 2001; Zucker e-mail

correspondence, February 22, 2001.) This cost avoidance would be of no financial benefit to WHMC at all, but was appropriately included as a benefit from the DoD perspective. This accounts for the entirety of the difference in perspectives, but was obviously significant enough to require evaluation of both perspectives. A scenario and sensitivity analysis was included for this benefit at Appendix F.

Anesthesia staff time savings

Although the preponderance of the literature indicated that some savings may be realized and quantified by saving the anesthesia staff time in recording data, Colonel Ellis denounced this notion for his department. Although it would benefit him if he was solely interested in justifying a pet project, he rationally predicted that the actual dollars saved would be zero. Even though 6 to 12 percent of the anesthetists' time in surgery would be freed to more closely monitor the patient, they would still be present in the OR for the same amount of time. They would not be freed up to attend to more patients; they would not be freed up to complete paperwork; the number of surgeries would not increase (Ellis interview, March 2, 2001.) The researcher agreed with Ellis, that no quantifiable benefit would be realized in anesthesia staff time.

The quality of care could be expected to increase, as the anesthetists could use their recording time to focus on the patient. This, in turn, could lead to some improvement in outcomes, resulting in shorter times to discharge. Any quantifying of this, however, would be speculative, so the estimated annual cash flow was still estimated at zero for this benefit.

Outcomes research/outcome improvement

Although one study indicated there was great potential for savings and quality of care improvements through outcomes research (Slogoff & Healy, 1985) further studies have inexplicably not followed. Since the industry standard is to grossly underutilize the research

capabilities of AARKs, the researcher hesitated to predict that WHMC would see real savings through outcomes research. The estimated value was zero, although enormous potential exists for great strides to be made in quality of care, education, and cost savings through outcomes research capable only with AARKs. Quantifying this was not possible; even scenario analysis would be purely speculative.

Best estimates gave an NPV of -$82,663 for this capital budgeting project from the perspective of WHMC. From the DoD's perspective however, the project would be worth an NPV of $1,389,354, with a payback period of only 2.687 years. It would take WHMC 8.210 years to earn back its cash outlays.

Discussion

"One of the greatest dilemmas in modern medicine is how to continue to improve…the quality of healthcare while maintaining a reasonable expenditure of resources (Barash, Cullen, & Stoelting, 1997.)"

Currently, WHMC has practically no anesthesia information management capability at all, and adds no data to the body of anesthesia research knowledge, except on a case-by-case basis. For practices, management and education to advance, data must be collected and evaluated, but the miltary's track record with the DoD-endorsed AARK, AIMS, and the negative NPV calculated for this project does not lead one to believe that purchasing AIMS out of O&M funds is the answer at this time.

Most of the sensitivity analyses performed revealed that NPV was quite sensitive to variations in costs and benefits. This indicates that much uncertainty exists in this capital budgeting project.

Small changes in the percentage of anesthetic savings realized seemed to have the most dramatic effect on NPV. A one percent change in savings would result in more than a $44,000 change in NPV. If 30 percent could be saved as opposed to 20, the NPV under the WHMC scenario would increase by $441,000, and nearly pay for itself within five years. That would be enough to make the project feasible even with O&M dollars.

Three others were highly variable, but not quite as sensitive to small changes. Workstations would be either compatible or incompatible. A difference in NPV of more than $220,000 between these scenarios makes this cost well worth pinpointing before purchase. Medicolegal benefits could show extreme variation from year to year, with zero likely to be the most common annual benefit, but multimillion dollar losses possible in any given year. Third party collections may be a focus of effort, since there is much room for improvement. Improving from the expected value to the best case scenario of 75 percent would add more than $140,000 to the project's NPV.

Had the data shown this project to be a winner for WHMC, the researcher would still have expressed concern. Most facilities do not use the capabilities of the expensive AARKs they purchase, and many facilities have found blunt opposition to using the AARKs. Lieutenant Colonel Thomas Grissom expects to remain at WHMC for at least six more years and flatly stated that he does not want a new system, unless a full-time analyst is assigned to his section. Staff buy-in and ownership has proven to be key to successful implementation of this technology, at BAMC and elsewhere. For this reason, the researcher highly recommends that Grissom be included in any discussions or team aimed at solving the lack of information management in anesthesiology. If an AARK is purchased, key stakeholders must be on board.

This analysis was complicated because so many of its variables have uncertain values in future cash flows. Since limited research has been done, precise estimates were impossible for variables such as staffing costs, drug savings, increase TPC, and medicolegal losses avoided. Even worse, some real benefits could not be quantified at all.

The qualitative value to society of outcomes research could be very significant, particularly if shared throughout the DoD and beyond. This value is not only in the form of reduced healthcare expenditures but includes improved quality and length of lives for many patients. It includes the value of educating Air Force medical providers in best clinical practices, thus further adding to capabilities to care for those who serve and who served this country in time of war.

It would be unreasonable for WHMC to pay the full bill for technology that would clearly be far more beneficial to the DoD. The expected result for WHMC of taking this initiative would be losing $350,173 in NPV; the expected result for the DoD of taking it would be gaining $1,121,844. If an AARK is purchased, DoD should pay, and WHMC should use this study as partial justification in its request for grant money.

There is more to consider, however, than just the results of the financial analysis. Substantial uncertainty exists, and AIMS is far from ideal for WHMC or for the DoD. Even with an NPV exceeding $1.1 million for this project, the DoD would have to risk $800,000 on an unproven system that would require a lot of things to go right to realize the projected benefits. It already tried AIMS at BAMC, and it failed due to incompatibility with existing systems, and poor staff acceptance. It was not easy to use, and down time was frequent.

The researcher had little time to evaluate Masterson and Trout’s proposal to purchase CareSuite by PiCis, but quickly gathered that this system would solve multiple issues WHMC

faces and has a much better record of success than does AIMS. This system priced out at more than $2.44 million, which was rumored to be an outstanding price for its capabilities. Masterson and Trout did not attempt to assign dollar values to benefits, so a comparison of systems was difficult. CareSuite had clear advantages over AIMS in systems compatibility, fulfilling multiple WHMC needs, and ease of use, which would go a long way towards earning user acceptance. Its scheduling capability could significantly increase the surgery department's workload capacity. It would offer all of the advantages of AIMS and much more.

If this research endeavor accomplished nothing else, at least it brought together key personnel to discuss the needs of the anesthesia department as they relate to the rest of WHMC. At a minimum, the researcher facilitated intelligent, informed communication between key stakeholders who will ultimately make a decision on this matter.

Recommendations

1) Do not buy AIMS at this time, especially with O&M funds.

2) Establish a team to collectively determine what would best serve the needs of the anesthesia department, in alignment with other existing needs and realities within WHMC. Lt Col Grissom should be an integral part of this team.

3) If the decision team decides an AARK should be purchased, use this project as partial justification for alternative funding, particularly to the DoD for grant money.

4) If the decision team decides to purchase an AARK on a limited or trial basis, begin with APVs. This will maximize TPC through itemization of all the anesthetics allowed by DoD, and would minimize the financial risk as the staff evaluates the potential value of the system upon full implementation.

5) If the decision is to purchase no AARK technology at this time, reevaluate the possibility within 3 years. By this time AIMS may prove to be compatible with CHCS II, as Van Hoozer projected.

6) Strongly consider purchasing CareSuite by PiCis, but seek alternative funding. The $2.44 million price out of WHMC's $144 million budget certainly warrants the effort.

Conclusion

Though the quantitative analysis cannot justify WHMC purchasing AIMS at this time, the potential qualitative and financial benefits of AARKs make them very attractive, especially to an anesthesia department with very primitive information management. An AARK would serve the facility's stated mission, and help WHMC to achieve its goals of readiness, education and training, and research, and would also help it attain its other goal of building healthy communities. Unfortunately, this is unlikely to be achieved cost-effectively with AIMS. Lack of compatibility with existing systems and staff resistance are factors which could derail the implementation process entirely.

Data should be kept. Outcomes should be researched. Information management should exist, but not with AIMS—at least, not now, and not from O&M funds.

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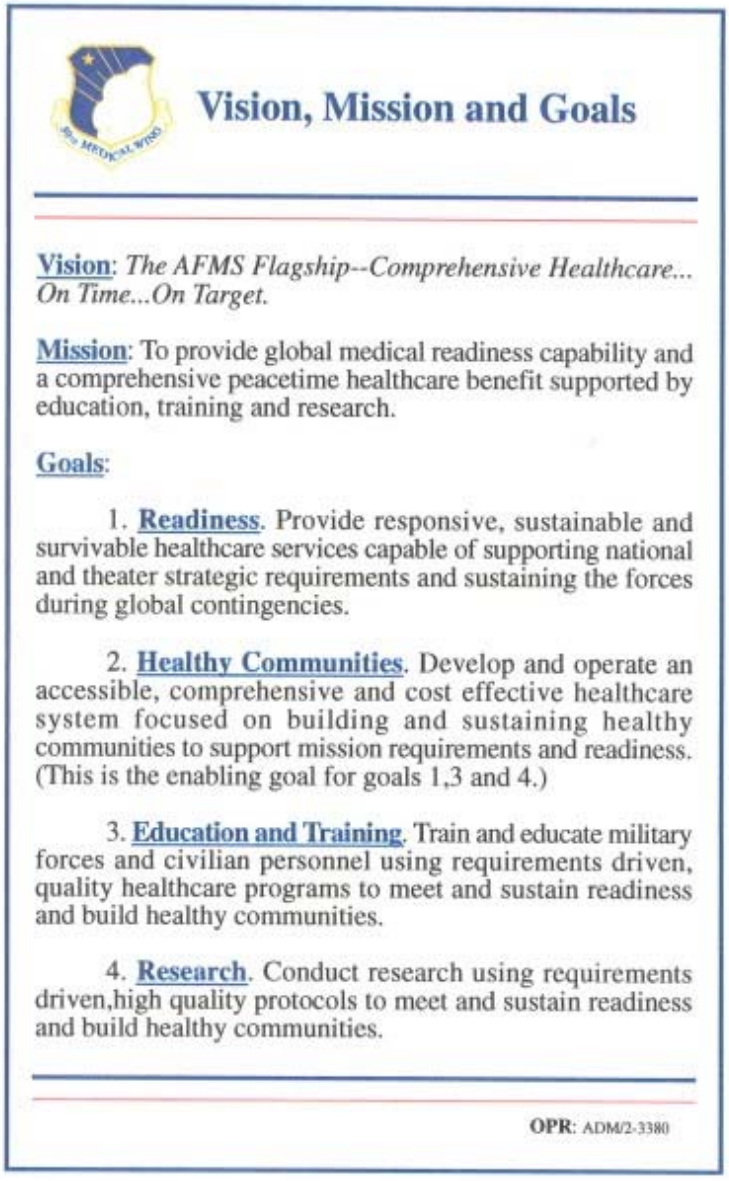
Appendix A—WHMC Vision, Mission, Goals



Vision, Mission and Goals

Vision: *The AFMS Flagship--Comprehensive Healthcare... On Time...On Target.*

Mission: To provide global medical readiness capability and a comprehensive peacetime healthcare benefit supported by education, training and research.

Goals:

1. **Readiness**. Provide responsive, sustainable and survivable healthcare services capable of supporting national and theater strategic requirements and sustaining the forces during global contingencies.

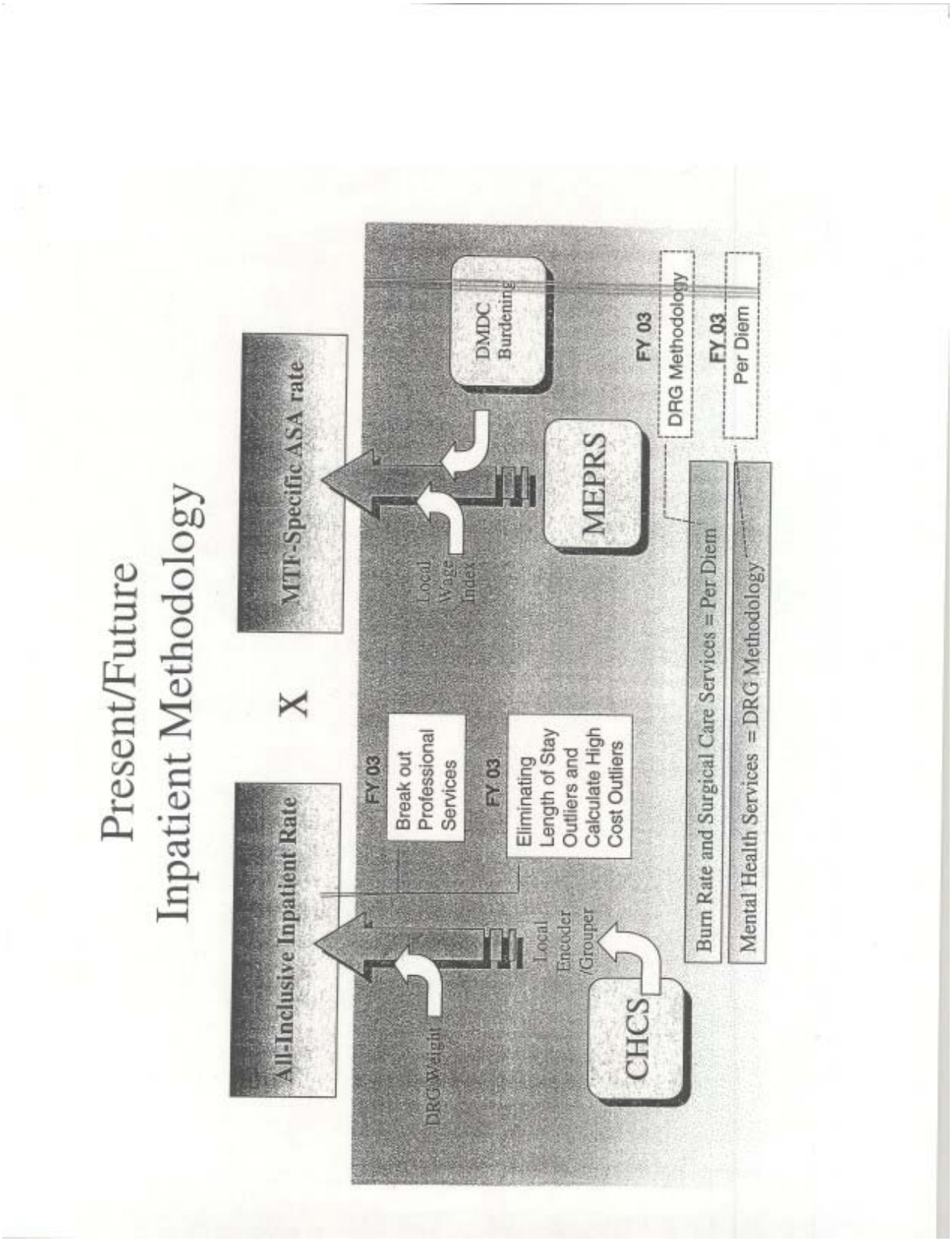
2. **Healthy Communities**. Develop and operate an accessible, comprehensive and cost effective healthcare system focused on building and sustaining healthy communities to support mission requirements and readiness. (This is the enabling goal for goals 1,3 and 4.)

3. **Education and Training**. Train and educate military forces and civilian personnel using requirements driven, quality healthcare programs to meet and sustain readiness and build healthy communities.

4. **Research**. Conduct research using requirements driven,high quality protocols to meet and sustain readiness and build healthy communities.

OPR: ADM/2-3380

Appendix B—Projected Inpatient Billing Methodology



Appendix C—Cost-Benefit Timeline: WHMC Perspective

Cost/Benefit Timeline: WHMC Perspective

	0	1	2	3	4	5	6	7	8	9	10	TOTAL
Costs												
System Purchase	640,000											640,000
Maint/Upgrades	0	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	48,000
Hardware												
- Purchase/Install	110,860											110,860
- Cables	8,280											8,280
- Workstations	0											0
- Data server	14,514											14,514
- Domain server	12,254											12,254
- Scanner	1,322											1,322
- Laser printer	2,300											2,300
- Bar code printer	1,200											1,200
- Optical Jukebox	3,200											3,200
- CD Tower	4,800											4,800
- Maint/Upgrades (15%*sum)	0	23,810	23,810	23,810	23,810	23,810	23,810	23,810	23,810	23,810	23,810	238,095
Additional Staffing												
- Billing--0.5 FTE		4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	46,000
- Systems Mgr/Data Analyst		40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	400,000
Supplies												
- Paper		3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	30,000
- Printer cartridges		400	400	400	400	400	400	400	400	400	400	4,000
TOTAL COSTS	798,730	76,610	76,610	76,610	76,610	76,610	76,610	76,610	76,610	76,610	76,610	1,564,825
Benefits												
Drug savings		120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	1,200,000
3rd Party Collections		15,334	15,334	15,334	15,334	15,334	15,334	15,334	15,334	15,334	15,334	153,340
Medicolegal		0	0	0	0	0	0	0	0	0	0	0
Supplies avoided		2,220	2,220	2,220	2,220	2,220	2,220	2,220	2,220	2,220	2,220	22,200
Anesthesiologist time		0	0	0	0	0	0	0	0	0	0	0
Outcome improvement		0	0	0	0	0	0	0	0	0	0	0
TOTAL BENEFITS	0	137,554	137,554	137,554	137,554	137,554	137,554	137,554	137,554	137,554	137,554	175,540
Annual Net Cash Flow	(798,730)	60,945	60,945	60,945	60,945	60,945	60,945	60,945	60,945	60,945	60,945	(1,389,285)
Cum Net Cash Flow	(798,730)	(737,786)	(676,841)	(615,897)	(554,952)	(494,008)	(433,063)	(372,119)	(311,174)	(250,230)	(189,285)	(155,995)
NPV (6% Discount Factor)	(798,730)	57,495	54,240	51,170	48,274	45,541	42,963	40,532	38,237	36,073	34,031	**(350,173)**
Payback (Yrs)	**13.106**											
10-yr NPV	**($350,173)**											

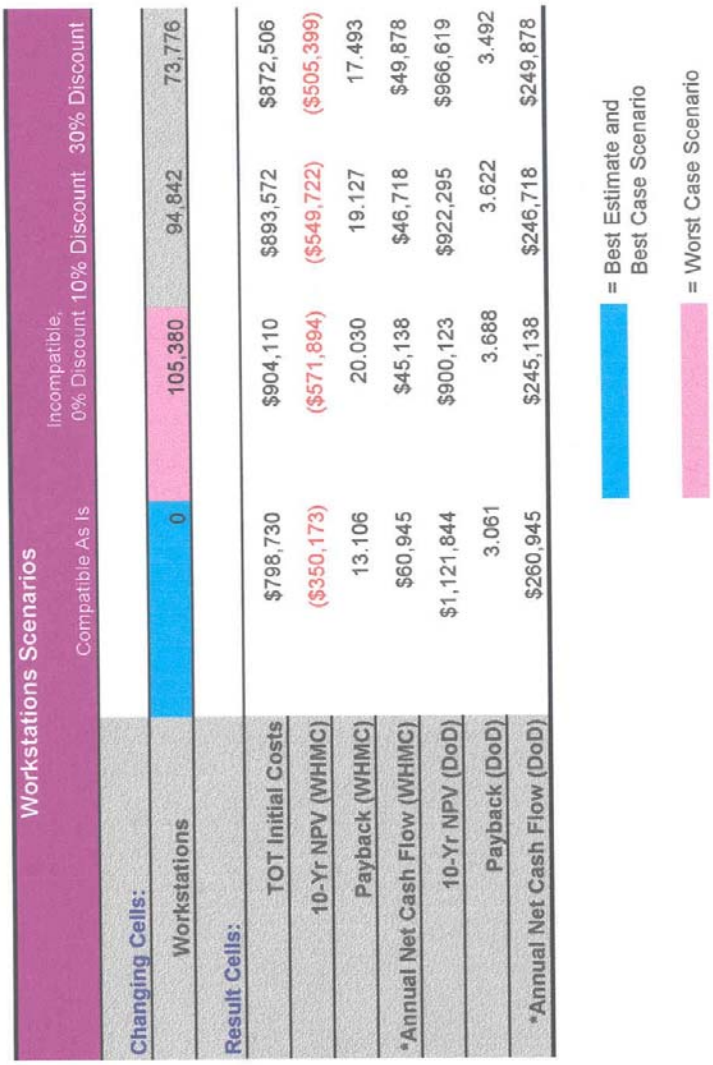
Appendix D—Cost-Benefit Timeline: DoD Perspective

Cost/Benefit Timeline: DoD Perspective

	0	1	2	3	4	5	6	7	8	9	10	TOTAL
Costs												
System Purchase	640,000											640,000
Maint/Upgrades	0	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	48,000
Hardware												
- Purchase/Install	110,860											110,860
- Cables	8,280											8,280
- Workstations	0											0
- Data server	14,514											14,514
- Domain server	12,254											12,254
- Scanner	1,322											1,322
- Laser printer, memory++	2,300											2,300
- Bar code printer	1,200											1,200
- Optical Jukebox	3,200											3,200
- CD Tower	4,800											4,800
- Maint/Upgrades (15%*sum)	0	23,810	23,810	23,810	23,810	23,810	23,810	23,810	23,810	23,810	23,810	238,095
Additional Staffing												
- Billing		4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	46,000
- Systems Mgr/Data Analyst		40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	400,000
Supplies												
- Paper		3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	30,000
- Printer cartridges		400	400	400	400	400	400	400	400	400	400	4,000
TOTAL COSTS	798,730	76,610	76,610	76,610	76,610	76,610	76,610	76,610	76,610	76,610	76,610	1,564,825
Benefits												
Drug savings		120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	1,200,000
3rd Party Collections		15,334	15,334	15,334	15,334	15,334	15,334	15,334	15,334	15,334	15,334	153,340
Medicolegal		200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	2,000,000
Supplies avoided		2,220	2,220	2,220	2,220	2,220	2,220	2,220	2,220	2,220	2,220	22,200
Anesthesiologist time		0	0	0	0	0	0	0	0	0	0	0
Outcome improvement		0	0	0	0	0	0	0	0	0	0	0
TOTAL BENEFITS	0	337,554	337,554	337,554	337,554	337,554	337,554	337,554	337,554	337,554	337,554	2,175,540
Annual Net Cash Flow	(798,730)	260,945	260,945	260,945	260,945	260,945	260,945	260,945	260,945	260,945	260,945	260,945
Cum Net Cash Flow	(798,730)	(537,786)	(276,841)	(15,897)	245,048	505,993	766,937	1,027,882	1,288,826	1,549,771	1,810,715	5,565,918
NPV (6% Discount Factor)	(798,730)	246,174	232,240	219,094	206,692	194,993	183,956	173,543	163,720	154,453	145,710	**1,121,844**

Payback (Yrs)	**3.061**
10-yr NPV	**$1,121,844**

Appendix E—Scenario Analysis: Workstations



Workstations Scenarios	Compatible As Is	Incompatible, 0% Discount	10% Discount	30% Discount
Changing Cells:				
Workstations	0	105,380	94,842	73,776
Result Cells:				
TOT Initial Costs	$798,730	$904,110	$893,572	$872,506
10-Yr NPV (WHMC)	($350,173)	($571,894)	($549,722)	($505,399)
Payback (WHMC)	13.106	20.030	19.127	17.493
*Annual Net Cash Flow (WHMC)	$60,945	$45,138	$46,718	$49,878
10-Yr NPV (DoD)	$1,121,844	$900,123	$922,295	$966,619
Payback (DoD)	3.061	3.688	3.622	3.492
*Annual Net Cash Flow (DoD)	$260,945	$245,138	$246,718	$249,878

= Best Estimate and Best Case Scenario

= Worst Case Scenario

Appendix F—Scenario/Sensitivity Analysis: System Manager Salary

Salary Scenarios--Systems Manager	$35K Contract	$40K Contract	$41K Contract	GS11 Employee
Changing Cells:				
System Manager/Analyst	35,000	**40,000**	*41000	59,472
Result Cells:				
10-Year NPV (WHMC)	($313,373)	**($350,173)**	($357,533)	($493,489)
Payback in Yrs (WHMC)	12.112	**13.106**	13.324	19.259
Annual Net Cash Flow (WHMC)	$65,945	**$60,945**	$59,945	$41,473
10-Year NPV (DoD)	$1,158,645	**$1,121,844**	$1,114,484	$978,529
Payback in Yrs (DoD)	3.003	**3.061**	3.073	3.308
Annual Net Cash Flow (DoD)	$265,945	**$260,945**	$259,945	$241,473

* Sensitivity results:$1,000 increase in salary results in
WHMC perspective
- A $7,360 decrease in NPV
- A longer payback by 78 days
DoD perspective
- A $7,360 decrease in NPV
- A longer payback by 4.4 days

=Best Estimate (blue)
= Best Case Scenario (green)
= Worst Case Scenario (pink)

Appendix G—Scenario/Sensitivity Analysis: Drug Savings

Drug Savings Scenarios	10%	15%	20%	*21%	25%	30%
Changing Cells:						
Drug Savings	60,000	90,000	120,000	126,000	150,000	180,000
Result Cells:						
10-Year NPV (WHMC)	($791,778)	($570,976)	**($350,173)**	($306,013)	($129,371)	$91,432
Payback in Yrs (WHMC)	845.664	25.812	**13.106**	11.931	8.783	6.604
Ave. Annual Cash Flow (WHMC)	$945	$30,945	**$60,945**	$66,945	$90,945	$120,945
10-Year NPV (DoD)	$680,239	$901,042	**$1,121,844**	$1,166,005	$1,342,647	$1,563,449
Payback in Yrs (DoD)	3.975	3.459	**3.061**	2.992	2.745	2.489
Ave. Annual Cash Flow (DoD)	$200,945	$230,945	**$260,945**	$266,945	$290,945	$320,945

* 1% additional drug savings results in
WHMC perspective
- $44,160 increse in NPV
- A shorter payback by 1.175 years

DoD perspective
- A $44,160 in NPV
- A shorter payback by 25 days

= Best Estimate (blue)
= Best Case Scenario (green)
= Worst Case Scenario (pink)

Appendix H—Scenario/Sensitivity Analysis: Third Party Collections

	TPC Scenarios: % of Billed Charges Collected					
	25%	33.3%	*34.3%	40%	50%	75%
Changing Cells:						
3rd Party Collections	11,501	15,334	15,794	18,401	23,001	34,501
Result Cells:						
10-Year NPV (WHMC)	($378,384)	($350,173)	($346,788)	($327,600)	($293,743)	($209,102)
Payback in Yrs (WHMC)	13.985	13.106	13.008	12.478	11.641	9.970
Annual Net Cash Flow (WHMC)	$57,112	$60,945	$61,405	$64,012	$68,612	$80,112
10-Year NPV (DoD)	$1,093,633	$1,121,844	$1,125,230	$1,144,418	$1,178,274	$1,262,915
Payback in Yrs (DoD)	3.107	3.061	3.056	3.025	2.974	2.851
Annual Net Cash Flow (DoD)	$257,112	$260,945	$261,405	$264,012	$268,612	$280,112

* Sensitivity results: 1% increase in % of billed charges collects

WHMC perspective

- A $3,385 increase in NPV
- A shorter payback by 36 days

DoD perspective

- A $3,385 increase in NPV
- A shorter payback by 1.8 days

=Best Estimate

= Best Case Scenario

= Worst Case Scenario

Appendix I—Scenario/Sensitivity Analysis: Medicolegal Benefit

**Medicolegal Benefit Scenarios						
Changing Cells:						
Annual Medicolegal Benefit	100,000	200,000	*201,000	300,000	200,000/2 yrs	***200K/2 yrs;$1M Yr 6
Result Cells:						
10-Year NPV	$385,836	$1,121,844	$1,129,204	$1,857,853	$364,398	$928,367
Payback (Yrs)	4.963	3.061	3.049	2.213	5.360	5.089
Ave. Annual Net Cash Flow	$160,945	$260,945	$261,945	$360,945	$160,945	$240,945

*Additional $1,000 cost avoided results in DoD perspective
- A $7,360 increase in NPV
- A shorter payback by 4.4 days

**Pertains only to the DoD perspective; WHMC does not pay for legal losses

***This scenario projects $200,000 in medicolegal benefits in years 2, 4, 8, and 9; $1M in year 6.

= Best Guess Scenario

= Greatest Benefit Scenario ("Best Case" seemed inappropriate)

= Least Benefit Scenario